Flight Dynamic Simulation with Nonlinear Aeroelastic Interaction using the ROM-ROM Procedure, Phase II

Completed Technology Project (2011 - 2013)

Project Introduction

ZONA Technology, Inc. proposes to develop an integrated flight dynamics simulation capability with nonlinear aeroelastic interactions by combining a flight dynamics model and an add-on nonlinear aeroelastic solver in a Simulink environment. This nonlinear aeroelastic solver is generated by interacting a nonlinear structural Reduced Order Model (ROM) with a Neural-Network-based (NN-based) aerodynamic ROM and a gust ROM to provide the incremental aeroelastic forces and moments of a classical flight dynamics model. In this way, the flight dynamics model is kept with minimum changes so that this integrated flight dynamics simulation remains in the frame work of a 6-degrees-of-freedom simulation environment. The nonlinear structural ROM employs an ELSTEP/FAT procedure that operates on a commercial nonlinear finite element software to construct the nonlinear stiffness matrices. The NN-based and gust aerodynamic ROM is generated using a system identification technique operating on a CFD code to evaluate the weights and biases in a two-layer feed-forward NN system. The end product is called FuNL-DFS that can simulate the key aeroelastic coupling mechanism between nonlinear structural dynamics and nonlinear unsteady aerodynamics with classical rigid body dynamics and can be used for control law development, maneuvering flight simulation, flight loads prediction and handling quality assessment. The FuNL-DFS system will be validated with the flight test data of the Predator B Aircraft.

Primary U.S. Work Locations and Key Partners
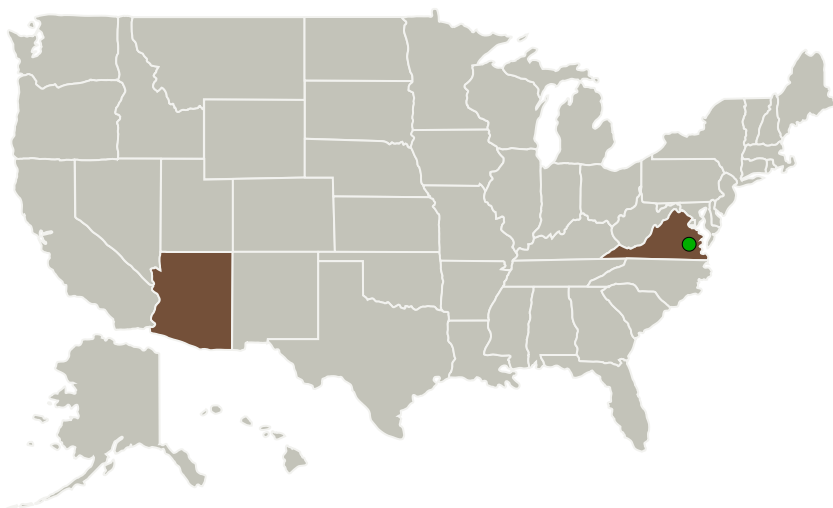
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Organizations Performing Work	Role	Type	Location
ZONA Technology, Inc.	Lead Organization	Industry Small Disadvantaged Business (SDB)	Scottsdale, Arizona
🟢Langley Research Center(LaRC)	Supporting Organization	NASA Center	Hampton, Virginia

Primary U.S. Work Locations	
Arizona	Virginia

Project Transitions

▶ **June 2011:** Project Start

✔ **September 2013:** Closed out

Closeout Documentation:
- Final Summary Chart*(https://techport.nasa.gov/file/138874)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

ZONA Technology, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Ping Chih Chen

Co-Investigator:
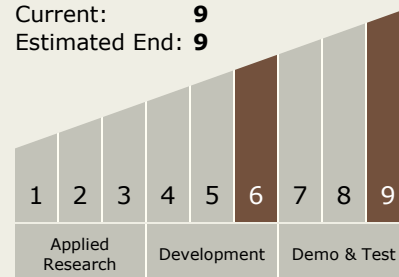
Ping Chih Chen

TechPort

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For more information and an accessible alternative, please visit:
https://techport.nasa.gov/view/9860

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Technology Maturity (TRL)

Start: **6**
Current: **9**
Estimated End: **9**

1	2	3	4	5	6	7	8	9
Applied Research			Development			Demo & Test		

Technology Areas

Primary:

- TX15 Flight Vehicle Systems
  └ TX15.1 Aerosciences
    └ TX15.1.3 Aeroelasticity

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System